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I. OPERATION

A. Product Description

The DANNIFLEX 500™ Continuous Passive Motion (CPM) system is designed for the rehabilitation of the lower limbs. The DANNIFLEX 500™ features anatomical alignment of the limb, and extended range of motion, the incorporation of muscle stimulation at any angle and the ability to incorporate controlled cyclical bilateral motion.

Selected Specifications

	Model 500
Weight	Approximately 32 lb. (14.5 kg)
Length	35.75 in. (91 cm), 43.75 in. (111 cm) with hip extension
Width	15 in. (38 cm)
Height	22 in. (56 cm)
Limb Length Accommodated	26.5 in. (67 cm) minimum, 42 in. (107 cm) maximum
Tibial Length	11 in. (28 cm) minimum, 18.5 in. (47 cm) maximum
Femoral Length	11.5 in. (29 cm) minimum, 19.5 in. (50 cm) maximum
Hip Height	Three settings: 3.25 in. (8 cm), 3.75 in. (9.5 cm), 4.25 in. (11 cm)
Range of Motion	− 10° extension to 125° flexion
Pause	0 to 30 sec. in extension and/or flexion
Muscle Stimulation	Available during motion and/or pause
Force Reversal	Adjustable
Bilateral Capabilities	Isochronal right and left leg treatment
Power	*120 VAC, 50 or 60 Hz, 0.12 amps*

B. Safety Features

The DANNIFLEX 500™ delivers less than 24 volts DC to the bed through the integrated plug-in power supply. While the unit is designed to operate on the standard electrical supply of 120 volts AC, 60 HZ, the 500 will tolerate electrical supply variations of 105-130 volts AC which may be found in the home or hospital environments.

The unit is designed to automatically reverse in the event that an obstruction occurs. The load reversal setting on the 500 is variable to accommodate a variety of limb weights and specialized therapeutic activities as prescribed by the physician and / or therapist.

The DANNIFLEX 500™ provides immediate patient access to all operating controls via the unique control pendant. Restricted access is also possible by means of a lock-out switch located on the CPM orthosis. An AUXILIARY START/STOP SWITCH is provided with the 500 device, eliminating patient interface with the control pendant.

The START/STOP BUTTON on the control pendant or the AUXILIARY START/STOP SWITCH gives the patient the ability to stop or interrupt the action of the unit should he/she experience discomfort. The patient can restart the unit (in the opposite direction) upon pressing the button or switch a second time.

C. Unpacking The Unit

Remove all the DANNIFLEX 500™ CPM system components from the carton.

Carton Should Contain:
1) One Operator & Service Manual
2) One DANNIFLEX 500™ Orthosis with Control Pendant
3) Femoral Adjustment Component
4) One Patient Kit (soft goods)
5) Auxiliary Start/Stop Switch
6) Bilateral Link Cable
7) Home Bed Mount Brackets

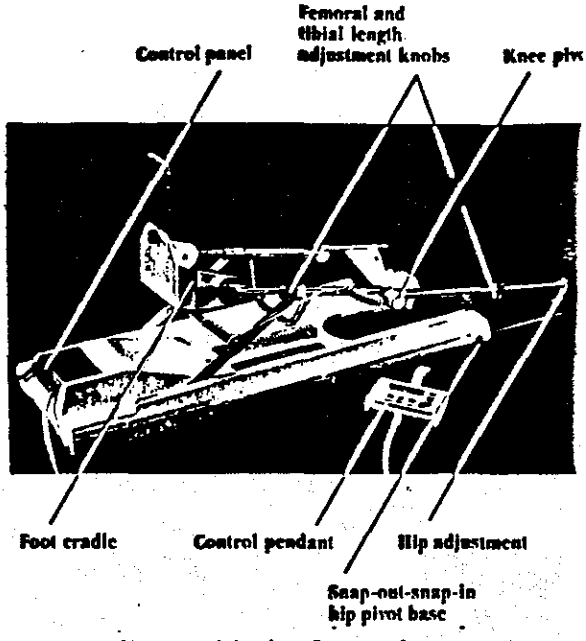
During unpacking, check for external damage. Report any substantial damage to shipper. Save packaging for storage when the unit is not in use. Additionally, if it is ever necessary to return for service, this packaging provides all the protection that is required under warranty.

D. Set Up

Remove the power cord plug from the storage receptacle located in the side of the foot cradle.

Ensure that both power cord and control pendant cord are uncoiled from the unit.

Locate the Femoral Adjustment Component, which will always be positioned to the lateral aspect of the limb. Therefore dependent on left or right lower extremity utilization, the femoral adjustment component will switch for the current patient application. The square tubing of the femoral adjustment component slides into the matching tubing at the base of the CPM device. Upon sliding, locate the pull pin latch at the base of the orthosis, pull the latch and continue to slide the femoral adjustment tube. Release the pull pin latch. The latch will return to the locked position upon matching with the hollowed opening in the square tubing of the femoral adjustment component. If the latch is pulled out and turned by one quarter turn, it will lock in the open position.

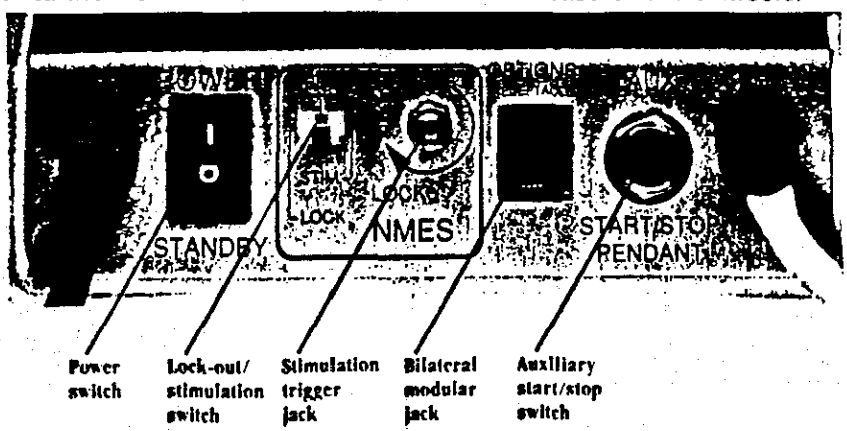


The round tubing segment of the femoral adjustment component aligns with the femoral cradle segment of the CPM device. A pull pin latch is incorporated with this segment. Upon sliding the tubing of the femoral adjustment component, pull the latch and release upon lining up the grooved sections of each tube, the pull pin latch will release indicating the link is locked and stable.

Plug the unit into a standard (grounded) wall outlet.

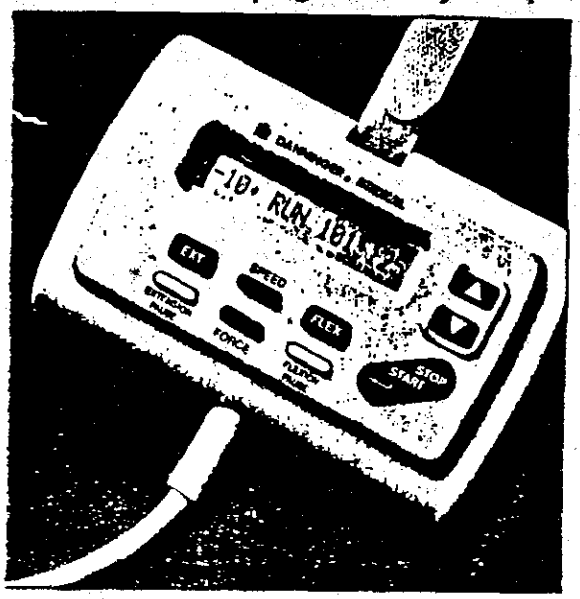
E. Operating The CPM

Turn unit on via the POWER SWITCH located at the base of the orthosis.



The Pendant LOCK OUT/MUSCLE STIMULATION SWITCH is located at the base of the orthosis. To change EXTEND, FLEX, SPEED, FORCE or PAUSE settings, place the pendant switch in the set position. Upon determination of the parameters, the START/STOP button must be depressed for the settings to be stored in the unit's memory. The pendant switch may then be moved to the locked position to ensure the established parameters "original settings", are maintained without continuous monitoring.

Upon completing the range of motion, speed, force, and pause setting, the Pendant Lock Out/Muscle Stimulation Switch may be moved to the muscle stimulation mode. Upon sliding the switch to the "Stim" mode, the incorporation of muscle stimulation will occur as programmed by the operator.

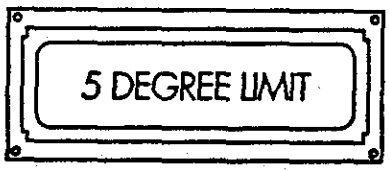


500 Control Pendant

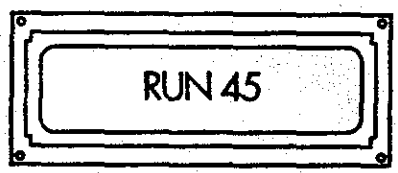
F. Step by Step

The DANNIFLEX 500™ provides a maximum Range of Motion (ROM) of -10 to 125 degrees. The ROM parameters are constantly displayed in the Extend (left) and Flex (right) display area of the control pendant. To change the parameters, depress and hold the EXTEND or FLEX buttons while simultaneously depressing the desired Δ Up or ∇ Down button. The Extend and Flex parameters will change slowly for the initial 5 degrees (allowing for precise adjustment); following this, the parameters will change rapidly to facilitate extensive modification.

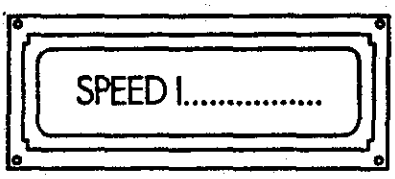
The orthosis has been designed for a 5 degree minimum ROM. Attempting to set the Extension and Flexion within this ROM results in a "5 degree LIMIT" message in the center of the display window.

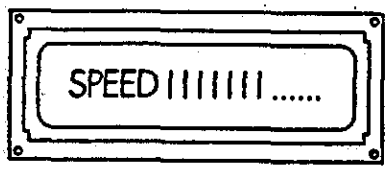


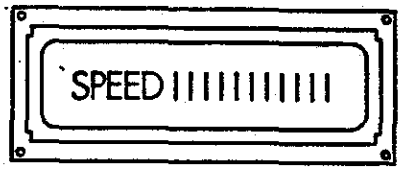
During normal operation, the center display area of the control pendant continuously displays the knee pivot angle of the CPM unit.

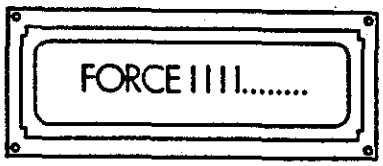


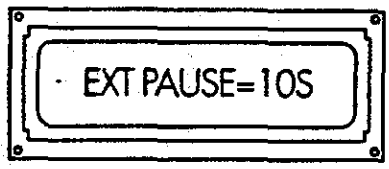
The DANNIFLEX 500™ operates at speed cycles of 1.5 to 10 minute/cycle. To check the speed setting, depress and hold the SPEED button. The center of the display window will indicate the present speed of the CPM by use of a bar graph. Minimum speed is represented by a single bar at the left of the cursor ling. Maximum speed is represented by all bars filling the cursor line in a left to right progression. To alter speed, depress and hold the SPEED button while simultaneously depressing either the Up or Down button.

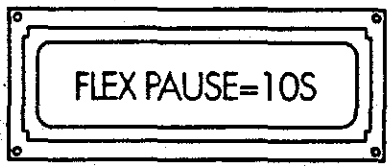












The DANNIFLEX 500™ incorporates a variable force reversal setting. To check the force setting depress and hold the FORCE button. The center of the display window will indicate the present force of the CPM by use of a broken line bar graph. Minimum force is represented by three broken lines at the left of the cursor line. Maximum force is represented by all bars filling the cursor line in a left to right progression. To alter force, depress and hold the FORCE button while simultaneously depressing either the Δ Up or ∇ Down button. (Adjustable force only affects the unit while running into flexion.)

PAUSE of 0 to 30 seconds may be selected at the end of the Extension and/or Flexion cycles. The pause setting can be checked by depressing the EXTEND and/or FLEX PAUSE and the number of seconds selected will appear in the center of the display window. To change the setting, depress and hold either the extend or flex pause button while simultaneously depressing either the Δ Up or ∇ Down button. When increasing both pause functions repeat the above steps for set up of each pause function separately (in a cycle).

To prevent inadvertent change to the chosen settings, place the Pendant Lock-out Switch in the LOCK position.

Attempting to alter any settings while in the Locked mode results in "Setting Locked" appearing in the center of the display window.

G. Step by Step--Neuro-Muscular Electrical Stimulation

Neuro-Muscular Electrical Stimulation (NMES) may be utilized during continuous passive motion therapy. Stimulation during motion, in static stretch/pause or both is available through the DANNIFLEX 500™ CPM system.

Upon completion of the original parameter settings for extension, flexion, speed, force and pause, move the Pendant Lock-Out/Muscle Stimulation Switch on the control panel of the orthosis to the "Stim" position.

H. MUSCLE-STIM INSTRUCTION

Immediately a message will begin to scroll across the control pendant display window:

"NMES↓ setup: Press ← keys to set all parameters.
Press ← key to enter data and continue."

Upon pressing the ←, which also functions as the start/stop button, the initial step of the "NMES" set up begins. the display window will read:

" ↓ direction Δ ∇ EXT".

EXT indicates the muscle stimulation direction and that stimulation will occur while the unit is moving into extension. To change the stimulation direction to flexion, press either the Up or Down button, on the pendant. Three choices are available for the direction in which muscle stimulation will fire, **EXT**, **FLEX**, or **NONE**. Identifying **"NONE"** as the stimulation direction allows stimulation to only occur in the Extension or Flexion Pause Mode and only for the number of seconds indicated during the "original" parameter setup phase.

Use the Δ Up or ∇ Down buttons to choose stimulation firing direction. Upon identifying, depress the ← button to confirm your choice and continue the setup.

If muscle stimulation is to fire while moving into extension or flexion, the next instruction screen will establish the **Low Muscle Stimulation Angle**. To change the angle, press the Δ Up or ∇ Down button on the control pendant. Upon determination of the low angle, press the ← to confirm the angle selection.

High Muscle Stimulation Angle selection will follow. To change the angle, press the Δ Up and ∇ Down button on the control pendant. Upon determination of the high stimulation angle, press the to confirm the angle selection.

The final selection phase of muscle stimulation setup is that of muscle stimulation **PAUSE**.

To incorporate muscle stimulation during **Extension Pause**, depress the Δ Up or ∇ Down button to indicate "YES". To confirm this selection, depress the ← button. To eliminate muscle stimulation during extension pause, depress the Δ or ∇ button to indicate "NO". To confirm this selection, depress the ← button.

Muscle stimulation during **Flexion Pause** utilizes the identical set up process as muscle stimulation for extension pause. Choose "YES" or "NO" and confirm by depressing the ← button.

Special Note: Muscle stimulation in extension or flexion pause will not operate if the muscle stimulation high and low angle parameter settings do not match that of the "original" range of motion parameters established.

Finally, the display window will read:

"Setup complete and settings locked..."

Press the ← button. This returns the display to the "original" range of motion screen, identifying the end parameters of motion and the current angle readout.

At this point, parameter set-up is complete, all settings for normal function and muscle stimulation are locked . There is no need to move the Lock-out switch from the "Stim" mode, but in the event you would need to, all muscle stimulation programming will be retained in memory.

During muscle stimulation and/or muscle stimulation pause, a lightening ↓ will appear in the center section of the display window to indicate muscle stimulation is firing.

5	↓ RUN 25	115
EXT		FLEX

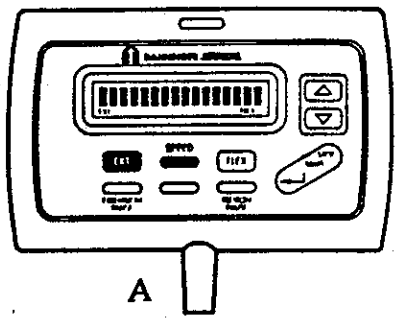
5	↓ PAUSE 15	115
EXT		FLEX

The DANNIFLEX 500™ CPM system is now programmed to incorporate muscle stimulation. The system currently incorporates utilization with three manufactured muscle stimulation devices, those available from Medtronic's, 3M and Staodynamics.

A NMES trigger jack located at the base of the orthosis accommodates a linkage cable, allowing the interface between the chosen muscle stimulator and the DANNIFLEX 500 CPM. The link cable appropriate for the chosen stimulator is available from Danninger. The use of Danninger provided link cables with locking plugs prevents inadvertent loss of synchronism between the CPM and the stimulator. Refer to the muscle stimulator instruction manual for proper setup.

I. Use of Patient Control Switch

The patient may stop and restart the CPM at any time by depressing the START/STOP button on the control pendant or the START/STOP button on the auxiliary patient control switch. The unit will proceed in the opposite direction upon restarting.

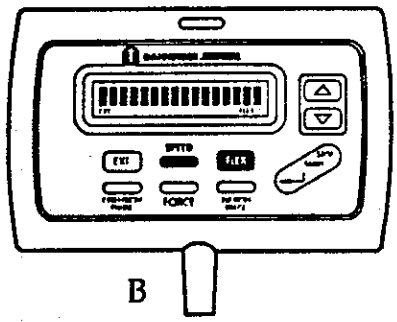


A

J. Memory Features

Each time the DANNIFLEX 500™ is powered-up, the Extend, Flex, Speed, Force and Pause settings will be the same as when the unit was last run.

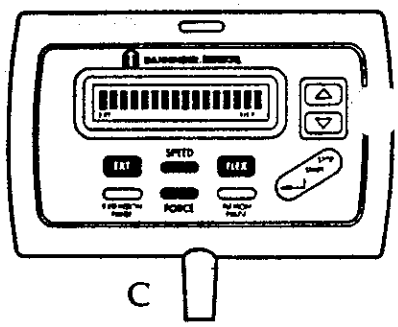
To check the Number of User Cycles of the CPM since the last reset, simultaneously depress and hold the EXTEND and SPEED buttons. "User Cycles" and the number will appear in the display window. (A)



B

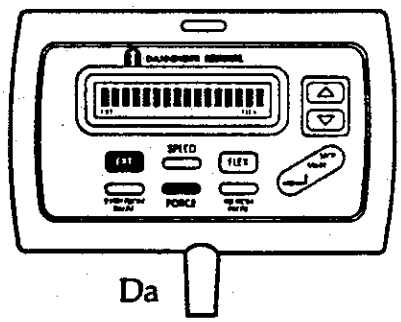
To check the Number of Hours of Operation since last reset, simultaneously depress and hold the SPEED and FLEX buttons. "User Hours" and the number will appear in the display window. (B)

To reset the User Cycle and Hours, depress EXTEND, SPEED, FLEX, and FORCE simultaneously. "RESET USER HRS&CYC" will appear in the display window. (C)



C

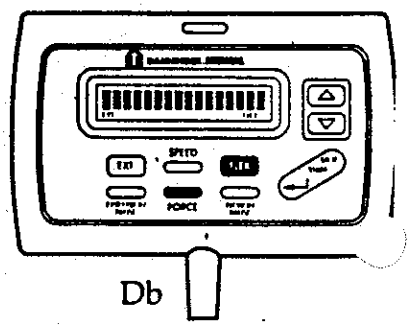
To check the Total Cycles since the unit was manufactured, depress EXTEND and FORCE simultaneously. (Da) For Total Hours since the unit was manufactured, depress FLEX and FORCE. Total cycles and total hours are non-resetable. (Db)



Da

K. Bilateral Application

Two DANNIFLEX 500™ CPM systems may be linked to provide a controlled cyclical motion for bilateral application. A receptacle identified on the control panel at the base of the orthosis as "OPTIONS" accommodates the link cable which connects the two CPM units and controls the cyclical motion.



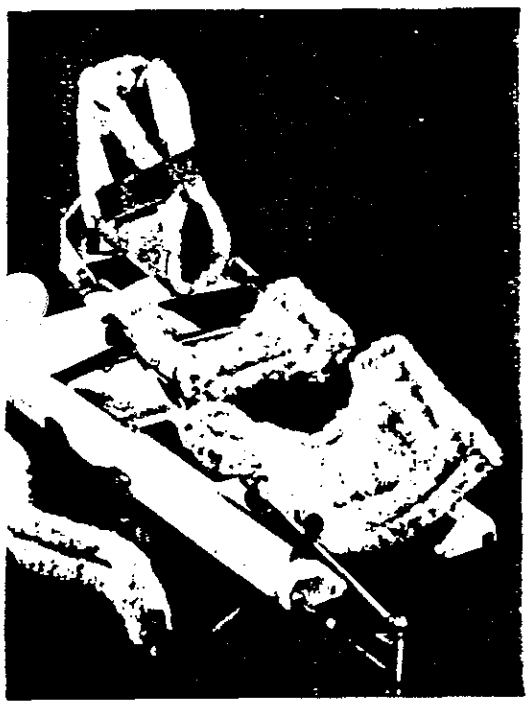
Db

The control pendant for each CPM system remains operative, the parameters for each unit remain accessible and the settings can be altered. Each control pendant will interrupt motion by depressing the start/stop button. The auxiliary start/stop switch will also function in the bilateral application for patient safety. Upon halting one of the CPM devices, the other stops. The same is true for reactivating the CPM devices.

The variation in parameter settings between the two CPM units is monitored internally to assure the cyclical motion is maintained throughout the application.

L. Attachment of the Patient Kit (soft goods) to Unit

Coverings for the DANNIFLEX 500™ are made of a synthetic material. Ease of adjustment offers the necessary limb support, provides a comfortable surface for prolonged contact with body surfaces.



Soft Goods

A boot, tibial support, femoral support and auxiliary strap complete each patient kit.

Begin with the femoral support piece. It is identified by the velcro strap located on the middle under surface of the support. Position this strap around the femoral strut of the carriage. The rounded edge of the support face the knee pivot hinges. Loop the velcro around the CPM frame and anchor the smooth under surface of the support. The velcro tabs are adjustable to provide the proper troughing and patient alignment.

Next, attach the tibial support piece. The rounded edge of the support must face the knee pivot hinges. Loop the velcro around the CPM frame and anchor to the smooth under surface of the support. Adjust the velcro tabs for proper troughing for the patient application and patient alignment.

Attach the boot by placing the elastic flap over the foot cradle (sole of boot adheres to foot plate.) After placing patients foot in the boot, fold the sides inward and attach the straps tightly to hold the foot securely.

An auxiliary strap is provided and may be used to securely hold the thigh or calf to the unit should enforced patient compliance be necessary.

M. Measuring Patient and Adjusting Length of Unit

Ensure the femoral adjustment segment is properly secured to the orthosis. Also, position the CPM leg carriage in extension when preparing for the patient fitting.

Determine the height of the patient's greater trochanter. Align the hip pivot of the femoral component to the greater trochanter of the patient. Pull the latch pin on the back of the femoral component and select one of the three positioning holes that best matches the patient's trochanter height. Release the latch pin to secure in place. Next, determine the length of the patient's femur. This measurement is taken from the greater trochanter to the center of the knee joint. The femoral length is then transferred to the CPM. The hip pivot hinge and the knee hinge are the starting and ending point for femoral length. To adjust this segment, loosen then depress the lateral adjustment knob. This allows the tubes to slide. Upon determining proper femoral length, release the knob and tighten securely.

To determine the length of the tibia and foot measure from the center of the patient's knee joint to 1/4 inch beyond the heel of the patient's foot, loosen the adjustment knobs on both sides of the cradle and adjust both sides equally. Tighten both knobs securely. If readjustment is necessary, do not attempt to adjust only one side of the calf cradle. this may cause mechanical damage to the unit.

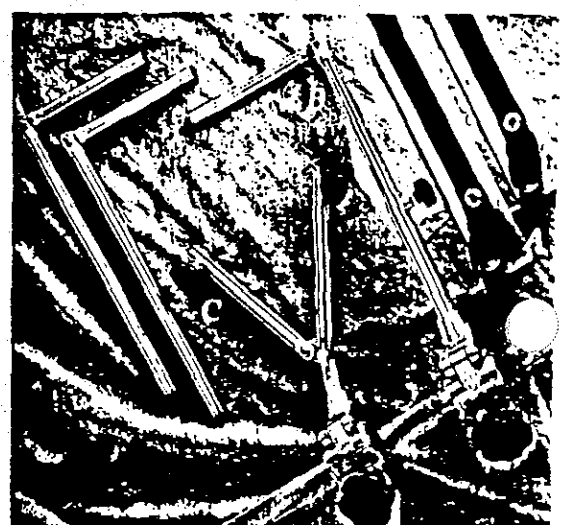
To allow free movement of the ankle, loosen foot adjustment knobs.

For rotation of the foot, loosen the adjuster knob located on the back of the Foot Cradle and reset to the right or left side as required.

N. Attaching the CPM System to the Bed

A Home Bed Mount (A) is provided for the DANNIFLEX 500™ and secures the CPM to the bed for home use. The home bed mount has straps which attach to the CPM via knobs which are located on both sides of the orthosis base near the foot of the unit. The CPM is secured to the bed with the "L" brackets that can attach to the mattress or the bed frame.

A Standard Hospital Bed Mount (B) is available for the DANNIFLEX 500™ CPM unit. This lightweight clamp provides stability and permits maximum flexibility for positioning the unit on the bed, allowing for abduction if prescribed.



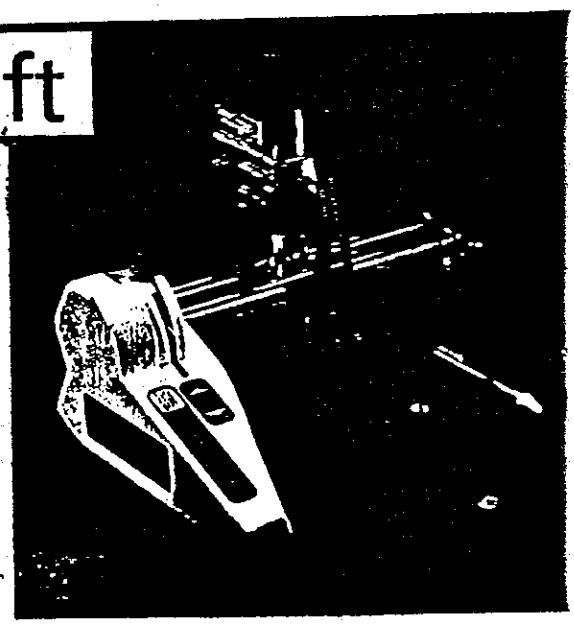
The standard bed mount will fit on either side of the CPM base. To adjust the position of the bed mount, loosen knobs, position the unit at any angle, and secure the knobs. (If the bed is raised or lowered, readjust bed mount to proper position.)

A Traction Hospital Bed Mount (C, previous page) is available by special order. It provides maximum stability to the CPM if necessary.

The traction bed mount differs from the standard bed mount in that the traction bed mount attaches to the CPM at two points thus forming a stable triangulated attachment.

For the hospital environment, the DANNILIFT™ system can be utilized with the DANNIFLEX 500™. The DANNILIFT is an "assist-lift" bed mount that attaches onto the frame of an orthopedic bed. The CPM is then attached to the DANNILIFT. The lift mechanism eliminates the need for medical staff personnel to lift, move, or store Danninger CPM equipment away from the bed.

Dannilift



The DANNILIFT also provides better infection control by eliminating the need to store equipment on unsanitary floors, chairs, or tables. It provides a user friendly alternative to reducing injury, time, and costly repairs of mishandled or stored equipment. This product could be utilized in any hospital setting that has orthopedic beds with horizontal traction frames located at the foot of the bed.

O. Recommended Care of the CPM Unit

Use a soft cleaning dampened with mild soap solution or alcohol (avoid abrasive cleaners) to gently wipe all exposed surfaces. To disinfect, it is common practice to wipe all exposed surfaces with a cloth dampened in a 10% solution of bleach and water.

P. Accessories /Cosmetic Parts Ordering Information

Description	Part No.
Soft Goods Kit	13387
Universal Knob Kit	11261
Universal Handle Kit	12260
Bilateral Cable	13398
Track Seal	13371
Patient Control Cable	13201
Small Rubber Pad (Bottom Cover)	13372
Large Rubber Pad (Bottom Cover)	13373
Product Identification Label	13340
Operator & Service Manual	13419
Foot Assembly	13361
Femoral Adjustment Component	13461
Plastic Rivet Kneepot Cover	12635
Kneepot Cover	13209
Pendant Label Back Cover	12587
Bed Mounts:	
Standard	12138
Traction	10363
Home	12200
DANNILIFT	13544
NMES Cables for:	
Medtronic Respond II	12183
Staodyne EMS Plus/Plus II	12184
3M Myocare / Meda M. S.	12185

II. SERVICE

A. Safety Precautions when Servicing the DANNIFLEX 500™ CPM System

1. CPM Safety Precautions

When servicing your CPM, to reduce the risk of fire, electric shock, and injury to service personnel the following basic precautions must be observed. Danninger Medical Technology will not be responsible for any injury resulting from any violation of the following safety precautions:

a. Read and understand all operating instructions.

b. Follow all warnings and instructions marked on the product.

c. Use only Danninger Medical parts for repair or replacement.

d. Never use parts from another manufacturer's unit even though they may appear to fit.

e. Never install the wall transformer with wet hands or in wet locations.

f. Never service this machine when transformer is installed in an outlet.

g. Only use the transformer supplied with the CPM. Never remove the transformer and plug the CPM directly into an electrical outlet.

h. Never touch uninsulated transformer wires or terminals unless the transformer has been unplugged from the outlet.

i. Do not service this machine near water.

j. Service this unit only on a stable table or workbench. Do not place the product on an unstable cart, stand, or table. The product may fall and cause injury to the technician or damage to the CPM.

k. This product should be operated only from the type of power source indicated on the marking label. If you are not sure of the type of power supply, consult your dealer or your local power company.

l. Keep hands, hair, and loose clothing away from moving parts when machine is in operation.

m. Do not overload wall outlets or use extension cords. The result in doing so, is a greater risk of fire or electric shock.

n. Do not allow anything to rest on the power cord or locate this product where the cord will be abused by persons, animals, or equipment moving on it or near it.

2. Explanations of Warnings Specific to the DANNIFLEX™ 500

On the DANNIFLEX™ 500 CPM System you will find two areas marked with the "See Accompanying Documents" symbol.

These areas are:

a) Under the leg cradle area at the pinch-point of the calf cradle - This is an area of possible interference. Patients must be advised to keep clear of this area when the CPM is in motion. Although the 500 is equipt with an automatic force reversal system. A patient or service technician could experience pain or be injured by the downward pressure of the cradle if they are positioned in such a way that some body part is under the cradle.

b) At the power switch area on the control panel - Note that the DANNIFLEX 500™ is "on" or in a "standby" mode if the unit is plugged in. To completely disconnect power from the CPM, it must be unplugged from the wall outlet.

3. Model 500 Regulatory Classes Defined

This Unit is classified by The International Electro-technical Commission (IEC) standards as Class II, Type "B", Category AP.

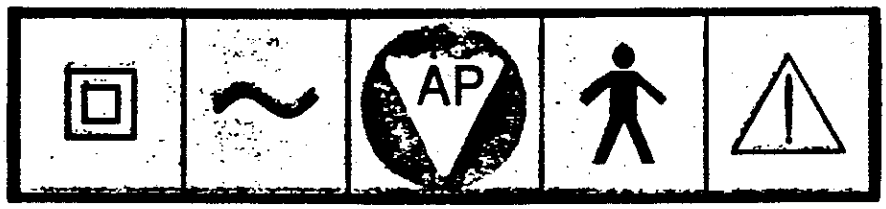
Definitions:

Class II - Equipment in which protection against electric shock does not rely on "basic insulation" only, but in which additional safety precautions such as, "double insulation" or "reinforced insulation" are provided, there being no provision for protective earthing or reliance upon installation conditions.

Type "B" - Equipment providing a particular degree of protection against electric shock, particularly regarding allowable "leakage current" and/or reliability of the protective earth connection (if present).

Category AP - Equipment or equipment part complying with specific requirements on construction, marking, and documentation in order to avoid sources of ignition in a "flammable anesthetic mixture with air".

1.4 Symbols Used on the DANNIFLEX 500



1 2 3 4 5

1. Unit is rated Class II
2. Unit requires AC power
3. Unit is classified Category AP
4. Unit is rated Type B
5. "See Accompanying Documents"

B. Introduction to Servicing The DANNIFLEX 500

1. Voiding of Warranty

Your DANNIFLEX 500 is covered by a One Year limited warranty. Any attempt at servicing the unit within this period will void your warranty. The warranty does not cover damage by accident, damage resulting from abuse, or unauthorized repairs or alterations. See section G of this manual for complete warranty information. If your unit is under warrantee and needs to be serviced, see section I of this manual for procedure on returning your unit for service.

2. Commonly Used Abbreviations

a. CPM - Continuous Passive Motion
b. PCB - Printed Circuit Board
c. CKT - Circuit
d. KP - Kneepot
e. Uc - Micro controller
f. PCC - Patient Control Cord
g. ROM - Range of Motion

3. Familiarity Statement

From this point onward, this document assumes a basic knowledge of the DANNIFLEX™ model 500 CPM device's operation. **If you are unfamiliar with the 500, please read the operation portion of this manual before proceeding.**

The following calibration parameters should always be checked after any repairs are completed on the model 500 CPM:

1) Range of motion
2) Force reversal

C. Service Level I

1. Qualifications and Equipment Needed for Service Level I

Individuals with an average level of mechanical ability should be capable of performing Level I maintenance tasks. You must have available and be proficient in the use of the following tools:

1. Diagonal Cutters
2. Hammer
3. Philips Head Screwdriver
4. Standard Screwdriver
5. Utility Knife

Disposable items required: Denatured Alcohol Solvent

2. Periodic Maintenance for Service Level I

The following list of tasks should be completed before and after each use:

1) Use a soft dampened cloth with a mild soap solution or alcohol and gently wipe all exposed surfaces. Avoid abrasive cleansers. To disinfect, wipe all exposed surfaces with a solution of 90% water and 10% bleach.

2) Ensure that all knobs are usable and in place.

3) Ensure that all tubes slide freely as required.

4) Check entire unit for any visible evidence of damage, such as bent tubes, cracked or broken covers, frayed or damaged wires, etc. If any signs of damage are found, the unit should be repaired before use.

5) Check all displays and electronic controls for proper operation.

3. Maintenance Instruction Service Level I

A. KNOBS

REMOVAL:

1) Approaching the unit from the thigh pivot end, cradle knobs are removed by turning the knobs on the right side of the unit toward you and removed from the left side of the unit by turning them away from you.

2) Approaching the unit from the power switch end, the knobs on the bed mount tubes are removed by turning the knob on the right side toward you and removed from the left side by turning the knob away from you.

INSTALLATION:

1) Approaching the unit from the thigh pivot end, cradle knobs are installed by turning the knobs on the right side of the unit away from you and installed on the left side of the unit by turning the knobs toward you.

2) Approaching the unit from the power switch end, the knobs on the bed mount tubes are installed by turning the knob on the right side away from you and installed on the left side by turning the knob toward you.

B. LABELS, SKID PADS, & VELCRO

REMOVAL:

1) Place the unit on a sturdy table or workbench.
2) Gently work off one corner of the label, skid pad, or Velcro using a utility knife.
3) Grabbing the corner of the label, skid pad, or Velcro firmly, peel it from the machine.

INSTALLATION:

1) Thoroughly clean the area the label, skid pad, or Velcro, was covering with denatured alcohol solvent.

2) Peel the protective backing off the label, skid pad, or Velcro, and place it on the unit in its original position.
3) Press firmly.

C. FOOT ASSEMBLY

REMOVAL:

1) Place the unit on a sturdy table or workbench.
2) Loosen both foot adjustment knobs until the foot tubes are free by using the procedure above.
3) Slide the entire assembly out until the tubes are "clear" of the cradle.

INSTALLATION:

1) With the unit in the same position, slide the foot tubes into the cradle.
2) Slide the Foot Assembly back to the desired position and tighten the adjustment knobs.

D. KNEEPOT COVER

REMOVAL:

1) Push centers of tiny plastic KP cover rivets through to center of casting.
2) With large pair of diagonal Cutters carefully pry out the rivets.
3) Pull cover off of Kneepot.
4) Store all hardware in a safe place for later reassembly.

NOTE: Remove center of KP rivet from casting by moving outer thigh tube so they fall out.

INSTALLATION:

1) Make a right angle bend in the KP cable insulation. It should be approximately inch from the end of the insulation. It is where the individual wires begin.
2) Install this bend in the KP cable retention slot in casting.
3) Install the KP cover over the casting aligning the cable with the small divot in the cover and in the casting with the holes in the plastic.
4) Install the outside of the plastic KP rivets into the mounting holes.
5) Install the center piece of the plastic rivets into the center of the plastic rivets.
6) With a small hammer gently tap the centers of the plastic KP rivet flush with the outside of the plastic rivet.

NOTE: Damaged plastic fasteners should not be re-used.

E. HANDLE

REMOVAL:

1) Place the unit, on its side, on a sturdy table or workbench with the handle facing you.
2) Using a Philips head screwdriver, remove the mounting screws. The screws are removed by turning them counterclockwise.
3) Remove the handle keeping all of the pieces together.

INSTALLATION:

1) With the unit in the same position, place the new handle over the mounting holes and start the screws in by hand. Note: The prongs on the bottom of the handle clamping device should line up with the small holes drilled in the bottom cover.
2) Tighten the screws (clockwise rotation) using the Philips head screwdriver.

D. Service Level II

1. Qualifications and Equipment Needed

In order to perform Level II maintenance, an individual must be above average in their mechanical ability and be able to solder and de-solder. They must have available and be proficient in the use of the following tools:

1. Philips Head Screwdriver
2. Standard Screwdriver
3. Diagonal Cutters
4. Allen (Hex) Key Set
5. Small Punch
6. Exacto-Knife
7. Soldering Iron
8. De-Soldering Equipment
9. Adjustable Wrench
10. Pliers

Disposable items needed: Solder, Tie-Wraps, Assure Loctite #42540 & #242

2. Periodic Maintenance for Service Level II

In addition to the items listed in Periodic Maintenance Level I which are done before and after each usage, the following list of tasks should be performed at the end of the first year of use and every six months thereafter:

1) Check all mechanical pivot and linkage points for smooth operation and secure mechanical connection. Make sure all screws, rivets, and pivot pins are secure.

2) Remove bottom cover and inspect all motor and ballscrew linkages and bearings for smooth operation and for excess wear. The ballscrew should have a thin film of light lithium based lubricant along its length. The Technical Service Department at Danninger uses *Lubriplate No. 105*.

3) Replace any missing or worn washers, spacers, bearings, or bushings.

4) Check all wiring, wiring connections, and circuit boards for secure mounting and clearance from moving mechanical components.

5) If there are any signs of improper operation the CPM should be repaired by a qualified service technician.

3. Maintenance Instruction Service Level II

A. Bottom Cover

REMOVAL:

1) Remove the handle by removing both Phillips screws.
2) There are two methods of removing the two piece plastic fasteners:

METHOD 1

a) Clamp the head of the fastener with a pair of diagonal side cutters.
b) Carefully squeeze the diagonal side cutters together while pulling the plastic insert out.

Caution: Do not cut the heads of the plastic fasteners off, undamaged fasteners may be reused. If the fasteners are damaged, new fasteners may be ordered using part #11274 (there are 9 fasteners in this kit).

c) Remove the plastic fastener's male portion.
d) Remove the plastic fastener's female portion.

METHOD 2

a) Using a thin blade standard screwdriver, remove the plastic fastener. Insert the tip between the plastic fastener's male portion and the bottom cover. There will be a "V" shape at that point.
b) Carefully rotate the screw driver.
c) Remove the plastic fastener's male portion.
d) Remove the plastic fastener's female portion.

3) Now carefully pull bottom cover off.
4) Store all hardware in a safe place for later reassembly.

INSTALLATION:

1) Carefully put the bottom cover on the base.
2) Align the bottom cover's holes with the top cover's holes.
3) Insert the female portion of the plastic fastener into their appropriate holes.
4) Insert the male portion of the plastic fastener female portion of the plastic fastener.
5) With a small hammer gently seat the male potion of the plastic fastener into the female portion of the plastic fastener.
6) Using a Phillips screw driver install the handle onto the cover.

Apply one drop of ASSURE Loctite #42540 on each handle screw before installation.

B. Cradle

REMOVAL:

1) Remove bottom cover.
2) Run cradle to maximum flexion.
3) Remove KP cable connector from J4 connector on the main PCB.
4) Using the diagonal cutters, remove the Tie-wraps from the underside of the top cover. Those which prevent the strain relief nut from coming off. Be careful to prevent damaging the KP cable when removing the Tie-wraps.
5) Remove strain relief from top cover by removing nut from under side of top cover.
6) Slide bottom strain relief nut off of cable end.
7) Slide rubber washer off of cable end.
8) Pull KP cable through top cover.

9) Carefully hand turn the ball-screws until both nylon slider-blocks gently touch the end of the base frame.
10) Remove the four mounting screws from the cradle strut ends and the slider block assemblies.
11) Lift the cradle through top cover.
12) Remove cradle from outer thigh tube.
13) Store all hardware in a safe place for later reassembly.

INSTALLATION

1) Carefully hand turn the ball-screws until both nylon slider-blocks gently touch the thigh end of the base frame.
2) Gently spread rubber track seals and slide cradle struts between track seals through top cover.
3) Slide cradle struts into drive pivot plates which attach the cradle to the slider block assemblies.
4) Using a hex key, install the four cradle strut mounting screws (Apply one drop of #242 Loctite on the threads of each screw before installation).
5) Slide KP cable through top cover.
6) Slide the rubber washer onto the KP cable.
7) Slide the strain relief nut onto end of cable.
8) Tighten the nut until it is ¼ turn beyond hand tight.
9) Tie-wrap the KP cable to the under side of the top cover. Leave enough cable to reach the J4 connector on main PCB .
10) Install two Tie-wraps just below the strain relief on the underside of the top cover. They should be chained together.
11) Install KP cable connector on main PCB J4 connector pins.
12) Install bottom cover.

C. Top Cover

REMOVAL:

1) Remove bottom cover.
2) Remove wall transformer ground wire from the CPM base frame with a Phillips screw driver and socket.
3) Remove connectors which connect the control panel (at foot end of CPM device) to the main PCB.

Note 1) USE CAUTION WHEN REMOVING ALL CONNECTORS TO PREVENT DAMAGE TO CONTROL WIRES ,CRIMP CONNECTIONS, ETC.

Note 2) The flat ribbon cable, from the control PCB, is removed by pushing down on the connector while pulling up on the cable.

4) Remove cradle.
5) Remove top cover.
6) Store all hardware in a safe place for later reassembly.

INSTALLATION

1) Place top cover on top of CPM base frame.
2) Install cradle.
3) Install all cable connectors from control panel at foot end of CPM to the main PCB.

NOTE: Cable connectors are installed on the following main PCB connectors:

Pendant cord.....J2
Foot end control PCB.....J3
Power switch cord.....J4-4,5

4) Install wall transformer ground wire on CPM base frame with a Philip's screwdriver and socket.
5) Install bottom cover.

D. MAIN PCB

REMOVAL:

1) Remove bottom cover.
2) Remove all connectors from main PCB.
3) Gently push the PCB toward the top cover until the nylon stand-off is disengaged from the main PCB.
4) Store all hardware in a safe place for later reassembly.

INSTALLATION:

1) Position the main PCB so all the connectors on the main PCB are facing the foot end of the CPM.
2) Place the main PCB above the nylon standoffs.
3) While guiding the nylon standoffs into the mounting holes, place the main PCB on them.
4) Gently pull main PCB toward bottom of base frame so the PCB seats firmly against the stopping pad on the nylon standoffs.
5) Install all connectors onto main PCB.

Cable connectors are installed on the following main PCB connectors:

Pendant Cable.....J2
Foot End Control PCB.....J3
KP Cable.....J4-1,2,3
Power switch cord.....J4-4,5
Motor cord..... J5

6) Install bottom cover.

E. CONTROL PANEL

REMOVAL:

1) Remove bottom cover.
2) Disconnect all connectors. They are routed from the control panel, on the foot end of the CPM, to the main PCB.
3) Remove wall transformer ground wire from CPM base frame with a Philip's screwdriver and a socket wrench.
4) Remove the six screws which mount the control panel to the top cover with a hex-key.
5) Carefully pull the wires through the cover.
6) Store all hardware in a safe place for later reassembly.

INSTALLATION:

1) Carefully push control panel wires through foot end of top cover.
2) Align top panel with cover mounting holes.
3) Using a hex-key install the six control panel mounting screws.
4) Install all connectors onto main PCB.

Cable connectors are installed on the following main PCB connectors:

Pendant Cable.....J2
Control Panel PCB.....J3
Power Switch Cord.....J4-4,5

5) Install wall transformer ground wire from CPM base frame using Philip's head screwdriver and socket wrench.

6) Install bottom cover (Section 1-2).

F. CONTROL PANEL PCB

REMOVAL:

1) Remove bottom cover.
2) Remove control panel.
3) Remove flat ribbon cable from control panel PCB.
4) Remove the nut from the PCC (Patient Control Cord) jack.
5) Remove the nut from the muscle stim jack.
6) Remove the control panel PCB.

NOTE: Make sure that the washers are still on the end of the PCC jack. They were between the PCC jack and control panel.

7) Store all hardware in a safe place for later reassembly.

INSTALLATION:

1) Install (8 conductor) flat ribbon cable into connector J2 on control panel PCB.
2) Install large fiber washer on PCC jack.
3) Lay control panel flat on a protective cloth to prevent scratching the finish.
4) Place control panel PCB in control panel so

G. PENDANT CABLE

REMOVAL:

1) Remove bottom cover (Section 1-1).
2) Remove control panel (Section 5-2).
3) Using a large diagonal side cutter carefully pry the strain relief out of control panel. Use caution to prevent damaging the strain relief.
4) Carefully pull cord through control panel.

Note: The connector, located at the end of the cable, should slip through the opening of the panel. This should happen when the connector is turned perpendicular to the closest edge of the panel.

5) Store all hardware in a safe place for reassembly.

INSTALLATION:

1) Measure from the end of the cable, 11.5 inches toward the pendant head. This is where the outside insulation of the cable ends.
2) Make a mark on the cable.

3) Install strain relief at this mark so the insertion end of the strain relief is pointed toward the cable connector.
4) Using a pair of pliers, squeeze both halves of the strain relief together.
5) Insert pendant cable through control panel toward inside of machine.
6) Press in strain relief.
7) Install control panel.
8) Install bottom cover.

H. POWER ASSEMBLY (TRANSFORMER)

REMOVAL:

1) Remove bottom cover.
2) Remove control panel.
3) Using a large diagonal side cutter, carefully strain relief out of control panel. Use caution not to cause damage to strain relief.
4) Disconnect transformer cable connection from the power switch.
5) Carefully pull transformer wires through the control panel.
6) Store all hardware in a safe place for reassembly.

INSTALLATION:

1) Measure from the end of the cable 3 inches toward the wall transformer. It is measured where the outside insulation of the cable ends.
2) Make a mark on the cable at this point.
3) Install strain relief at this mark so the insertion end of the strain relief is pointed toward the power switch connectors.
4) Insert wall transformer cable through control panel toward inside of machine.
5) Using a pair of pliers squeeze both halves of the strain relief together.
6) Press in strain relief.
7) Install control panel.
8) Install bottom cover.

I. POWER SWITCH

REMOVAL:

1) Remove bottom cover.
2) Remove control panel.
3) Remove transformer wires from switch.
4) Remove main PCB power connector wires from switch.
5) Carefully, with a pair of pliers, squeeze the locking tabs of the switch housing together. Accomplish this while pushing the switch though the control panel.
6) Store all hardware in a safe place for later reassembly.

INSTALLATION:

1) Position the power switch so the "0" on the rocker part of the switch is to the closest cut edge of the panel.
2) Carefully push the switch into the appropriate position.
3) Install transformer wires on the power switch terminals that are closest to the top of the panel.
4) Install main PCB power wires to the bottom terminals of the power switch. The V+ PCB wire connects to the power switch terminals directly below the white transformer wire connections. This is viewed with the CPM machine in the operating mode position.
5) Install control panel.
6) Install bottom cover.

Note: Make sure that both white wires are on one side of the switch and both black wires are on the other side.

J. MOTOR

REMOVAL:

1) Remove bottom cover (Section 1-1).
2) Remove motor connector from main PCB (J5).
3) With hex-key remove the four screws that hold the motor adapter plate to the four rubber motor mounts.
4) Remove internal tooth star washers from between plate and rubber mounting spacers.
5) Remove the motor from the CPM.
6) Remove rubber coupling from either motor or bearing bracket assembly.
7) Store all hardware in a safe place for later reassembly.

INSTALLATION:

1) Insert the rubber coupling into the bearing bracket assembly.
2) Position the motor in the base. The adapter plate holes align with the rubber motor mounts. The motor coupling aligns with the rubber coupling.
3) Put an internal tooth star washer between each of the rubber mounting spacers and the motor adapter plate.
4) Insert the four motor mount screws and tighten. Be careful not to twist the rubber mounting spacer when tightening the screws.
5) Install bottom cover.

K. BEARING BRACKETS AND DRIVE BELTS

REMOVAL:

1) Remove bottom cover.
2) Remove motor.
3) With a hex-key remove the two mounting screws which mount the drive shaft bracket mount the bearing bracket to the frame.
4) With a hex-key and socket wrench remove the two mounting screws which mount the drive shaft bracket mount the bearing bracket to the base frame.
5) With a hex-key remove the eight screws which mount both ball-screws to the base frame.
6) Pull bearing bracket upwards until it just clears the base frame.
7) As viewed from the foot end of the CPM, twist the bracket toward the right hand ball-screw until belt comes off.
8) Store all hardware in a safe place for later reassembly.

INSTALLATION:

1) Carefully rotate both ball-screws toward the foot end of the CPM. Do this until both ball-screw nuts snug up against the end of the ball-screw.

NOTE: IN THE NEXT SEVERAL STEPS BE SURE THAT NEITHER BALL-SCREW NUTS MOVE OR THE CRADLE WILL BE MISALIGNED.

2) As viewed from the foot end of the CPM, install a ball-screw drive belt onto the left-hand ball-screw drive pulley.
3) Position the bearing bracket so the pulleys point toward the foot end.
4) Install the drive belt on the inner most pulley.
5) position the bearing bracket where it will mount to the CPM base frame.
6) As viewed from the foot end of the CPM, install a ball-screw drive belt onto the right-hand ball-screw drive pulley.
7) Install a drive belt on the outer most bearing bracket pulley. Twist the bracket assembly outer pulley toward the disconnected ball-screw.
8) With a hex-key install the eight ball-screw mounting screws in both ball-screws mounting flange. Apply one drop of #242 LOCTITE on each of screws before installation.
9) With a hex-key and socket wrench install the bearing bracket mounting screws.
10) With a hex-key install the drive shaft bracket to CPM base frame. Apply one drop of #242 LOCTITE on each screw before installation.
11) Install motor.

L. BALL-SCREWS

REMOVAL:

1) Remove bottom cover.
2) Remove cradle.
3) Remove top cover.
4) Remove motor.
5) Remove bearing bracket and drive belts.
6) To remove right side ball-screw, move the ball-screw toward the foot end of CPM. Then lift the ball-screw upward. This is as viewed from the foot end.
7) Mark this ball-screw as right side ball-screw.
8) Remove drive pivot pin which attaches the cradle to the slider block.

NOTE: When you remove this pin, there is a plastic washer between the side pin and the slider block.

9) Repeat steps 6,7, & 8 for the left side ball screw.
10) Store all hardware in a safe place for later reassembly.

INSTALLATION:

1) Install plastic washer on drive pivot pin.
2) Install the drive pivot pin in the right side ball-screw. The flat section should be toward the outside.
3) Install the right side ball-screw in the base fame's right hand side.
4) Repeat steps 1,2, & 3 but substitute the word left where the word right appears.
5) Install the bearing bracket and drive belts.
6) Install the motor.
7) Install the top cover.
8) Install the cradle.
9) Install the bottom cover.

M. KNEEPOT CABLE

REMOVAL:

1) Remove bottom cover.
2) Remove Kneepot cover.
3) Remove KP cable connector from connector (J4 pins 1,2, &, 3) on main PCB.
4) Use the large diagonal cutters to remove all Tie-wraps from KP cable.

5) Remove connector end from KP cable.
   a) With a thin tip screwdriver or xacto-knife remove the connector's pins.
   b) Push the tabs on the metal pins toward the connector housing's center of the connector housing.
   c) Then push the pins out of the connector housing. The metal tabs are accessible through the slots on the side of the connector.
6) Remove strain relief from top cover by removing the nut on the bottom side of the top cover.
7) Slide bottom strain relief nut off of cable end.
8) Slide rubber washer off of cable end.
9) Pull cable through cover.
10) Unsolder cable from terminals on KP.
11) Remove top section of strain relief by loosening top nut and sliding the cable through strain relief.

NOTE: Caution must be taken when pulling the KP cable ends through the connector to insure that you do not bend the fragile ends.

12) Store all hardware in a safe place for later reassembly.

INSTALLATION:

1) Position the top half of the strain relief on longest straight end of KP cable so the domed end points toward the coils.
2) Move strain relief to coils.
3) Tighten the top nut ¼ turn passed finger tight.
4) Strip off enough insulation to wrap one complete turn around KP terminals.
5) Wrap wires around KP terminals and solder as follows:

KP pins	KP cable
1	Blue
2	Orange
3	Yellow

6) Install KP cover.
7) Install new Tie-wraps on cradle.
8) Carefully put KP cable through top cover.
9) Put rubber washer on KP cable.
10) Install bottom strain relief nut on KP cable.
11) Tighten strain relief bottom nut ¼ turn passed hand tight.
12) Install KP cable connector on cable end.

NOTE: KP cable connector pins are:

1 - Orange
2 - Blue
3 - Yellow

13) Install new Tie-wraps on bottom side of top cover.
14) Install new Tie-wraps (2 chained together) just bellow strain relief on underside of top cover.
15) Install KP cable connector onto main PCB (connector J4 pins 1, 2, &, 3)
16) Install bottom cover.

E. SERVICE LEVEL III

1. Qualification and Equipment Needed for Service Level III

In order to perform Level III maintenance an individual must be highly skilled in both mechanical and electrical repair. They must be proficient in the use of the following tools:

1) 500 Angle Fixture
2) .1 Center Jumper
3) Philips Head Screwdriver
4) Hammer
5) Diagonal Cutters
6) Allan (Hex) Key Set
7) Small Punch
8) Exacto-Knife
9) Soldering Iron
10) De-Soldering Equipment
11) Adjustable Wrench
12) Pliers

Disposable items needed: Solder, Tie-Wraps, Loctite #42540 & #242

2. Periodic Maintenance for Service Level III

In addition to performing the items listed in the Periodic Maintenance for Service Level I and II, persons performing Level III maintenance should also do a calibration check while performing the Level II scheduled maintenance. The calibration check should include both angle and speed calibration. All parameters which do not comply with specifications should be re-calibrated.

3. Maintenance Instruction Service Level III

A. CIRCUIT DESCRIPTION

1) Micro controller Circuit:

a. uC (micro controller) description:

1. The MC68HC11F1 has:
   * 1024 bytes RAN
   * 512 bytes PROM
   * 8 channel 8 bit analog to digital converter (A/D)
   * Serial Peripheral Interface (SPI) (synchronous)
   * Serial Communications Interface (SCI) (asynchronous)
   * Computer Operating Properly (COP) Watchdog System
   * Programmable Chip Selects
   * Real-time Interrupt Circuit
   * 8 bit pulse accumulator
   * Non multiplexed Expanded Awareness/Data Bus
   * Block Protect Mechanism for EPROM and CONFIG

2. The 500 uses an 8 KHz crystal. The uC I/O ports are all configured to inputs when the uC is reset.

b. Memory:

EPROM: 64K EPROM "27C512"

c. The micro controller (uC) found on the 500 main PCB is a Motorola MC68HC11F1. Additional information on the chip can be found in Motorola P/N MC68HC11F1/D Technical Data . Information generic to the MC68HC11 Series can be found in Motorola P/N M68HC11 RM/AD 68HC11 Reference Manual. Both Documents can be obtained through Motorola and should be referred to if you have a specific technical question.

2) Power Supply Circuit

a. Consists of:

SE2 - DPST
Q7 - LM7805
Q8 - LM7808
Q9 - MC34064
POWER TRANSFORMER

Q7 - provides all logic supply voltage.

Q8 - provides analog supply for U5, A/D reference, etc.

Q9 - provides reset on power down and low line voltage. This will prevent the uC from reading instructions when shutting down or when there isn't enough line voltage for the uC to function properly.

SE2 - on off switch for the CPM.

POWER TRANSFORMER - provides power to all circuits. It feeds the voltage regulators and the motor.

3) Motor Circuit

Consists of:

U4 - 74HC164
U6 - MC33035
U7 - MC33039
Q1,Q3,Q5 - MTP3035E
Q2,Q4,Q6 - MTP2955E
Dl - lN5248A
D3 - lN4002
Rl ,R3,R5 - 3.01k Ω
R2,R4,R6 - lk Ω
R7 - .5 Ω l w
R8,R9,R10,R13 - 470Ω 1/4w 5%
Rll - 100kΩ
Rl2,R14,R28 - l0kΩ
R16 - 4.99kΩ
RNl - 10k SIP R2R Ladder
Cl,C2,C3,C5,C6,C7,Cl9,C20,C21 - .01μf
C4 - 1.0 μf
K1 - 24v relay
Ml - Brushless motor

U6 - MC33035 Motorola brushless controller IC. This chip performs all the basic commutation for the motor.

M1 - A 3-phase BLM (Brushless motor) which has 3 sensors located 120° apart. Three of the BLM wires are for sensor wires. Two wires comprise the sensor power wires. Three wires make up the phase wires.

Rl,R2,R3 - Pull up resistors for the open collector output of the MC33035.

Cl,C2,C3 - Spike filtering for the gates of Q2, Q4, and Q6 respectively.

R14 & C6 - Regulate the MC330309's pulse width output.

Rll, R12 & C4 - Condition the input of the MC33035 to provide a closed-loop speed control system.

R16 & C7 - Determines the MC33035's pulse width modulation.

R13, C5 & Dl - Determine at what voltage the output is inhibited when the V+ line goes below preset voltage level.

Cl9, C20, C21 - The input sensors' Noise filter.

U4, R28, RNl - Sets the motor's primary speed.

K1 & D3 - This shoots the windings together to prevent the motor from coasting when power is off.

4) Kneepot Circuit

Consists of:

R24 - lMΩ
U5 - LM358
Rpot - lkΩ

R24 - Pull down resistor is used to produce an error if the wiper connection is of Rpot is severed.

U5-A - Unity gain op-amp that provides isolation between the Rpot and the A/D input.

Rpot - The Kneepot that is attached to the knee pivot point of the cradle. This determines the knee pivot angle.

5) Force Circuit

Consists of:

U5 - LM358
R7 _ .5Ω 1w 1%
R27 - lOkΩ
R26 - lkΩ
R25 - 4.99 kΩ
C13 - 10μf Tantalum Capacitor

R7 - This provides the force sense voltage. As the motor is sequenced through its rotation, it drops a small amount of voltage across this resistor. This voltage will be proportional to the amount of torque that is applied to the motor.

R27 & C13 - Low pass filter. This will attenuate all transient spikes to prevent false force reversals.

U5-B - Force signal conditioner.

R25 & R26 - Adjusts the voltage gain of the amplification stage.

6) Pendant Circuit

a. LCD
Consists of:
RP1 - 470Ω
UP3 - 74HC164
LCD-Module 1 X 16

RP1 - Determines how bright the LCD module is.

UP3 - Serial to Parallel converter, this chip provides all the LCD information by converting the Serial data to Parallel data when the LCD module is enabled.

LCD - Contains all necessary circuitry to drive the LCD module. It is a self contained unit. All that is supplied to the unit is address data and E clock.

b. Keypad
Consists of:

S1-S9 - Rubber keypad
RNP1 - 4.7kΩ sip
UP1 - 74HC30
UP2 - 74HC165

S1-S9 - Rubber keypad for the pendant and upper pendant board.

RNP1 - Pull up resistors for the keypad. When the keypad is in it's normal state of rest these resistors pull the key pad lines high.

UP1- Octal nand input gate. This is used to alert the uC that a key has been depressed. The only key which isn't connect is the Start/Stop key. The Start/Stop key goes directly into the uC.

UP2 - This provides Parallel to Serial converter. When a key is activated, UP2 transfers the code for the depress key to the uC via the serial bus.

7) Control Panel PCB Circuit

The muscle stim jack, SET/LOCK/STIM slide switch, bilateral connector, and auxiliary PCC jack comprise the foot panel control. The foot PCB is connected to the main PCB by an 8 conductor ribbon cable.

a. MUSCLE STIM CIRCUIT:
Consists of:
U3 - UDN2595A
D2 - IN5248A
R18, R20, R21 - 100kΩ
Q10 - J177

U3 - This is an output isolator. It allows the FET gate to be pulled high (to V+) and turn the muscle stim (FET) on.

D2 & R18 - This voltage divider prevents an over voltage condition on the gate of the FET.

R20 & R21 - provide bias and gate isolation for Q10.

Q10 - Output FET for stimming. When the FET is high impedance, the stim unit should be stimming. When the FET is low impedance the Stim unit should be off.

b. SET/LOCK/STIM slide switch:
Consists of:
SE1 - single pole three position switch.
U3 - UDN2595A

SE1 - This tells the uC whether the unit is in the stim mode, the lock mode or the set mode. The center wiper is grounded. The SET and STIM position are connected to U3 and are pulled high through internal pull up resistors. If there happens to be any problems occur with the line, the unit will go into the stop mode.

U3 - Isolates the uC from the external interfaces.

c. BILATERAL:
Consists of:
JE2 - 4 place phone jack
U3 - UDN2595

JE2 - Phone jack that provides coupling to another CPM unit. The two outer positions are grounded and the signals are applied to the inner two. Pins 2 is used for receiving incoming data while pin 3 is used for transmitting data.

U3 - Is for ESD(Electro-static Discharge)and power supply isolation. It has internal pull-up resistors on the inputs and open collector outputs that are pulled high. This is connected to the uC through the serial port.

NOTE: If you plug a standard telephone handset into the bilateral jack, you should hear a clicking noise. This indicates that it is transmitting.

When one unit is plugged into another, they both continue to transmit data. The data is interpreted and if data meets the set requirements the unit enters the Bilateral Mode.

The only rules enforced in the bilateral mode are:

1) Both units cannot run into flexion.
2) The unit cannot run with both bilateral and stim active.

If the bilateral mode is active and the phone cable is disconnected, the unit reverts to normal single unit mode after 1.3 seconds. The CPM will always STOP when leaving the bilateral mode.

d. AUXILIARY START/STOP
Consists of:
JE4 - phone jack
U3 - UDN2595A

JE4 - The patient control cord plugs into this connector. It is normally closed. When the switch is open the uC senses this. It changes mode of operation from start to stop, or from stop to start.

U3 - Is for isolation. It will provide isolation from ESD.

B. CALIBRATION

1) Procedure

Tools Required:
protractor
jumper clip

a) Turn off CPM.
b) Gain access to main PCB by removing bottom cover of base.
c) Jumper together Jl-5 and Jl-6, The PCB is marked 'CTE' at that jumper. CTE stands for Cal Test Enable.
d) You should now proceed to Turn the CPM On.
e) The micro controller (uC) will do the following:

1) If this is the PCB's first calibration. It will initialize the timer, cycles, and variables. If the uC cannot initialize a variable, the pendant will display:

'EEPROM ERR [E6]'.

2) Check the EE_ERROR byte. Many error conditions are programmed to write their corresponding error code to this byte. If EE ERROR does not equal zero, the pendant will display an error code. For example:

'[E10] ← TO ZERO'.

would indicate that the last error generated by the CPM was E10. Referring to section 2 ERROR CODES, you will find that E10 indicates: either an open in the Kneepot wiper or Kneepot 8v wire. If the EE ERROR is zero, it indicates errors do not exist. The uC will skip the above display. To reset the EE ERROR to zero, press the START/STOP button. When more than one error exist, they will overwrite all previous one. New error codes overwrite old ones.

3) Check the EE TEST STATUS byte. When the main PCB is tested on the DMT P/N 13385 Functional test fixture, any detected errors are displayed. An error code corresponding to the detected error is burned into the EE TEST STATUS byte. Errors are generated by out of tolerance components, etc. . If nothing was detected, the functional test fixture sets EE TEST STATUS = 0. When a unit without errors is later calibrated, the 'TEST STATUS' display is skipped. If the unit being calibrated has a non-zero EE TEST STATUS, then you will see the following display:

'TEST STATUS = NN'

where NN is an error code which can be found in section 4 of this document.

If NN = 255, the PCB has never been tested on the 13385 test fixture. If NN displays something other than 255, you should contact the factory.

f) Choose motor type

With revision B01 software and newer, the option of utilizing a different Brushless Motor was incorporated. At this point the pendant display should show:

' MOTOR TYPE? (Δ/∇) O '.

Where (Δ/∇) is the up/down symbol and O is the last character on the display line is the first letter of the motor's manufacture's name.

Use the Δ/∇ keys to select the appropriate type of motor and press the START/STOP key.

g) Set Extension CAL Point

The display should show:

'EXT [40-50] NN'.

Where NN is the Kneepot voltage reading from the uC's A/D converter.

The 500 thigh tube should be released from the cradle. Apply the protractor to the unit. Adjust the cradle to the zero degree position. NN should be rechecked to assure that it is greater than 39 but less than 51. Now, the EXTENSION key should be pressed. pressing EXTENSION key burns NN into the EE EXT CAL byte in EEPROM and clears the EE CAL STATUS byte to zero. If you press EXTENSION and NN is out of range the display will show:

' see manual '

h) Set Flexion CAL Point

The display should show:

' flx [210-240] NN '.

Where NN shows the Kneepot voltage reading of the uC's A/D converter.

Adjust the cradle so the knee pivot measures 125° with the protractor. If step f) was performed correctly the value of NN will be between 210-240. Check that this is true, and if so press the FLEXION key. Pressing FLEXION key burns NN into the EE_FLEX_CAL byte in EPROM. It sets EE CAL STATUS bit to 0. If you press FLEXION and NN is out of range, the display will show:

' see manual '.

Note: When judgment is used, it is better to calibrate the unit at 124°.

i) Check Extension Limit:

It must protect the patient against all types of CPM failures. In particular Kneepot voltages which are out of the standard range (caused by opens in the Kneepot circuit) should stop the unit. Towards this end the uC needs to be able to tell the difference between a carriage at the extension or flexion mechanical limit and an open Kneepot wire. The display should now show:

' EXT LIMIT CK NN '.

Where NN shows the Kneepot voltage reading of the uC's on board A/D converter.

Move the carriage to the mechanical extension limit, and press EXTENSION key. If (10 <= NN <= 36), the uC will set bit 1 of EE_CAL_STATUS and go on to the next screen. If the unit does not, the unit will display:

' see manual '.

j) Check Flexion Limit

Check the mechanical flexion limit. This is because of reasons given in i). The display should now show:

FLX LIMIT CK NN'

Where NN shows the Kneepot voltage reading of the uC's on board A/D converter.

Move the carriage to the mechanical flexion limit, and press FLEXION key. If (210 <= NN <= 250), the uC will burn bit 2 of EE_CAL_STATUS. Then it will go on to the next screen. If not, the unit will display:

' see manual '.

k) Force Check

The torque/speed curve of a brushless motor is consistent from unit to unit. It is also constant over time. Thus we do not calibrate force, but concurrently we need to check that the unit does not bind anywhere in it's range. To pass the force

check the unit must run without binding or being stopped from 125 to -10 or vice-versa. The display should now show:

' FORCE CHECK [←] '.

press START/STOP on the pendant. The unit will begin running and display:

'AAA FOR[SSS]= NNN'.

Where AAA = Kneepot angle in degrees.
NNN = Measured Force.
SSS = Force reversal set point.

If there are no binding problems and the unit runs from -10° to 125° , the uC will set bit 3 of EE_CAL_STATUS . This stops the unit. The display should show:

' CAL COMPLETE '.

If you have not removed the jumper, do so now.

If NNN > SSS for about 1 second the unit will stop and the display will show:

' BINDING [←] '.

If you now press the pendant START/STOP, the unit will again run in the force check mode. However, if instead you insert the Auxiliary Pendant and press it, the unit will run and display:

'AAA RUN-IN F NNN'.

Where AAA = Kneepot angle in degrees.
NNN = Measured Force.

In RUN-IN mode the unit will not force reverse. This has been found useful because some minor binding problems can be solved by simply running the unit. However, there is the danger that major binding problems will cause the fuse to blow.

2) Notes On Calibration

a) Jumper

(Jl-5 to Jl-6) must be installed during calibration and removed immediately following calibration completion.

b) Force Check Shortcut

There may be times when the FORCE CHECK procedure is needed but the angle calibration is OK. In this situation it is possible to jump from the angle cal display:

' ext [40-50] NN '

directly to FORCE CHECK by pressing the FORCE key. If EE_ EXT_ CAL and EE _FLEX_ CAL contain good values (within limits) program execution will jump to FORCE CHECK. If not, no action will be taken.

c) EE_CAL _ STATUS:

This byte allows the uC to detect the calibration status of the unit. For instance, if the EE_ EXT_ CAL byte was programmed, then the machine was turned-off and started in normal mode. There must be some indication that the value of EE_ FLEX_CAL may not be correct. The values of the EE_CAL_ STATUS have the following significance to the calibration procedure:

ACTION	EE_CAL_STATUS bit							
	7	6	5	4	3	2	1	0
program EE_EXT_CAL	0	0	0	0	0	0	0	0
program EE_FLEX_CAL	0	0	0	0	0	0	0	1
CHECK EXTENSION LIMIT	0	0	0	0	0	0	1	1
CHECK FLEXION LIMIT	0	0	0	0	0	1	1	1
FORCE CHECK	0	0	0	0	1	1	1	1

If bit 0 is not set, indicating that angle calibration has not been successfully completed, the unit will display:

' CALIBRATE [El] '.

The unit won't run if bit 1,2 or 3 is not set, the unit will display:

' CALIBRATE [←] '.

on power-up. This indicates the lack of limit of force checks. If you press return, the unit will proceed to the normal display.

F. APPENDICES

1. MECHANICAL DIAGRAM (EXPLODED)

not completed

2. MECHANICAL PARTS LIST

not completed

3. ELECTRICAL SCHEMATIC

not completed

4. ELECTRONIC PARTS LIST

not completed

5. ERROR CODES

Errors are handled on a case by case basis. Detection of some errors stops the CPM. At that time it will display an error code. It then burns the associated error code into the EE_ ERROR byte in EPROM. While for other lesser errors, the only action taken is to burn the code into EPROM. The specific actions of each error are detailed below. Whenever the EE_ ERROR byte in EPROM contains a non-zero value the unit will-display:

' **** WAIT **** '

on power-up for about one second. This indicates an error condition was detected at some time. After the " **** WAIT **** " display you will see either the normal screen or a fatal error code. The EE_ERROR byte is reset by getting into the calibration mode. See the calibration section of this document for more details.

CODES:

[E1]: KNEE PIVOT ANGLE CALIBRATION ERROR.

ERROR ACTION: This error prevents the CPM from entering the run mode. It also causes the pendant to display:

' CALIBRATE [El] '.

CAUSE: An invalid Knee Pivot Angle Calibration is indicated by Bit 0 of EE_CAL_STATUS being 0.

CORRECTIVE ACTION: Perform the calibration portion of this service manual on the CPM.

[E2]: MECHANICAL LIMIT CHECK OR FORCE CHECK VALIDATION ERROR.

ERROR ACTION: This error causes the CPM's pendant to display:

' CALIBRATE [←] '

on power-up. It will run normally, after the START/STOP key has been depressed.

CAUSE: The extension limit check, the flexion limit check, or force check was not fully executed. This action occurs, when the unit was calibrated.

CORRECTIVE ACTION: Perform the calibration portion of this service manual on the CPM.

[E3]: EE EXT CAL OR EE FLEX CAL EPROM VARIABLE ERROR.

ERROR ACTION: The error prevents the CPM from entering the run mode and causes the CPM to display:

' CALIBRATE [E3] '.

CAUSE: On power-up the uC checks the values of EE_EXT_CAL and EE_FLEX_CAL. Limits are imposed on the value of these variables at calibration. If the value read from EPROM is not within these limits, the variable is assumed to be corrupted. An error is generated.

CORRECTIVE ACTION: Perform the calibration portion of this service manual on the CPM.

[E4]: SOFTWARE TIMER ERROR.

ERROR ACTION: This error causes the uC to burn 4 in the EE_ ERROR EPROM. After further power-ups, the CPM displays:

' **** WAIT **** '.

CAUSE: A software variable called Timer Overflow Interrupt count (toi_ count) is incremented every time the timer overflows. After the value of toi count becomes greater than 2746 the timer value in EPROM is incremented (it keeps track of l0ths of hours) and the 2746 is subtracted from toi_ count. If for some reason this process fails and toi_ count becomes greater than 32,000 error 4 is generated.

CORRECTIVE ACTION: Contact the Danninger Medical Service Department informing them of the error and replace either the uC or the PCB.

[E5]: MOTOR SPEED MEASUREMENT ERROR.

ERROR ACTION: This error causes the uC to burn 5 in the EE_ERROR EPROM and causes the CPM to stop. After further power-ups, the CPM displays:

' **** WAIT **** '.

CAUSE: With every revolution of the motor, the MC33039 detects when the sensor in the motor makes a transition. That is when the sensor goes from high to low or low to high. It generates a pulse of fixed width. The uC measures the speed of the motor, by counting the number of pulses that occur in one timer overflow period. This happens in 131 seconds. When the unit runs too fast (over 230 RPM), the time between sensor transitions becomes less than the pulse width. The uC counts 0 pulses, therefore the speed measured = 0. Even though the motor is revolving.

CORRECTIVE ACTION: Trouble shoot PCB (MC33039 0SC resistor-Capacitor combination may be out of tolerance. There can be excessive noise on the Hall effect sensor inputs, a bad MC33039, a bad uC, etc...). Reset EE _ERROR byte by entering the calibration routine.

[E6]: EPROM INITIALIZATION ERROR.

ERROR ACTION: The error prevents the CPM from entering the run mode. It also causes the CPM to display:

'EPROM ERR [E6] '.

CAUSE: During initial calibration certain variables in EPROM are initialized. If there is some problem and one of these variables cannot be written to EPROM, error 6 is generated.

CORRECTIVE ACTION: Perform the bulk erase procedure. If that doesn't affect a cure, replace the uC or the main PCB.

[E7]: CYCLE COUNTER ERROR.

ERROR ACTION: This error causes the uC to burn 7 in the EE_ ERROR eprom. After further power-ups the CPM displays:

' **** WAIT **** '

CAUSE: Every time the unit pauses in extension a variable in the software called *cycles since save* is incremented. Every six minutes of operation the timer is incremented and the total cycle count is increased by the *cycles since save*, after which cycles since save is zeroed. If this process goes awry and *cycles since save* becomes greater than 500 error 7 is generated.

CORRECTIVE ACTION: Contact the Danninger Medical Service Department informing them of the error and replace either the uC or the PCB.

[E8]: MOTOR SPEED ERROR.

ERROR ACTION: This error causes the uC to burn 8 in the EE _ ERROR eprom and causes the CPM to stop. After further, power-ups the CPM displays:

' **** WAIT ****'

CAUSE: The maximum CPM rpms is less than 200. If the speed measured is greater than 254 counts in one timer-overflow (roughly 500 rpm) then error 8 is generated.

CORRECTIVE ACTION: Trouble shoot PCB (MC33039 0SC Resistor-Capacitor combination out of tolerance, excessive noise on the Hall effect sensor inputs, a bad MC33039 , a bad uC, etc....). Reset EE_ ERROR byte by entering the calibration routine.

[E9]: START/STOP ERROR.

ERROR ACTION: This error causes the uC to burn 9 in the EE_ ERROR eprom and causes the CPM to stop. After further power-ups, the CPM displays:

'**** WAIT **** '.

CAUSE: The uC has detected that the START/STOP key has depressed for more than 16.4 seconds. The START/STOP on the main or auxiliary pendant may have been depressed for that period. The PCC (patient Control Cord) may have an open circuit. The push button is normally closed. The main pendant may have a short circuit. It is normally open. The foot PCB ribbon cable may not be properly installed.

CORRECTIVE ACTION: Trouble Shoot the pendants and the main and foot PCB's. Reset EE_ERROR byte by entering the calibration routine.

[E10]: KNEEPOT WIPER VOLTAGE TOO LOW.

ERROR ACTION: This error causes the uC to burn 10 in the EE_ERROR eprom. It causes the CPM to stop. The pendant displays:

' ANGLE ERROR [E10] '.

After further power-ups the CPM displays:

'**** WAIT **** '

CAUSE: The Kneepot wiper or +8v may have an open. The main PCB may have a problem.

CORRECTIVE ACTION: Examine the Kneepot, the Kneepot cable, and Kneepot connector for possible opens, and troubleshoot the main PCB. Perform the extension limit check in the calibration mode to assure that the cradle is not traveling outside the Kneepot's voltage range. Reset EE_ERROR byte by entering the calibration routine.

[E11]: KNEEPOT WIPER VOLTAGE TOO HIGH

ERROR ACTION: This error causes the uC to burn 11 in the EE_ERROR eprom, causes the CPM to stop. It also causes the pendant to display:

'ANGLE ERROR [E11] '.

After further power-ups, the CPM displays:

' **** WAIT **** '.

CAUSE: The Kneepot ground may have an open. The main PCB may have a problem.

CORRECTIVE ACTION: Examine the Kneepot, the Kneepot cable, and Kneepot connector for possible opens. Then troubleshoot the main PCB. Execute the flexion limit check in the calibration mode, to assure that the cradle is not traveling outside the Kneepot's voltage range. Reset EE_ERROR byte by entering the calibration routine.

[E12]: BILATERAL MODE ENTRY ERROR.

ERROR ACTION: This error causes the CPM to stop. The display should show:

' NO BILATERAL & *stim* '.

(the lightening bolt symbol shows up instead of ' stim ')

CAUSE: Stim and bilateral operation cannot be performed concurrently.

CORRECTIVE ACTION: Check that the slide switch is not in the stim position while in the bilateral mode. If the switch is not set to the stim position and the error persists check the switch, the foot PCB, and the ribbon cable connectors for proper operation.

[E13]: EPROM VARIABLE ALLOCATION ERROR.

ERROR ACTION: This causes the uC to burn 13 in the EE_ERROR eprom. After further power-ups, the CPM displays:

' **** WAIT **** '.

CAUSE: Each variable, in software, has a predetermined amount of EPROM dedicated to it. The reason being that each byte of EPROM can be written to only a finite number of times. Upon copying a variable to EPROM the uC checks that the copy matches the original. If it does not match it goes on to the next byte of EPROM and tries to write it again. Eventually, there may come a time when the variable runs out of the EPROM that was allocated for it. This generates an error 13.

CORRECTIVE ACTION: Either replace uC or PCB. Contact Danninger Medical Service Department and inform them of this type of error (there should be enough EPROM allocated for each variable to last for more than a decade of constant use).

[E14]: EPROM POINTER ALLOCATION ERROR.

ERROR ACTION: This causes the uC to burn 14 in the EE_ERROR eprom. After further power-ups, the CPM displays:

' **** WAIT **** '.

CAUSE: Each variable in software has a predetermined amount of EPROM dedicated to it. The reason being that each byte of EPROM can be written to only a finite number of times. Upon copying a variable to EPROM the uC checks that the copy matches the original. If it does not match, an "EPROM pointer" byte is incremented so the uC is directed to the next byte of EPROM. It proceeds to write the variable again. However, if the EPROM pointer, a byte of EPROM, cannot be incremented, an error 14 is generated. The variable cannot be written to the EPROM correctly.

CORRECTIVE ACTION: Either replace uC or PCB. Contact Danninger Medical Service Department and inform them of this error. The maximum number of pointer burns is equal to the number of EPROM bytes allocated for that variable. This is a small number in comparison with the minimum number of times a byte of EPROM can be bused is 10,000.

[E15]: KNEEPOT WIPER VOLTAGE NOT CHANGING QUICK ENOUGH.

ERROR ACTION: This error causes the uC to burn 15 in the EE_ERROR eprom. This also causes the CPM to stop. After further power-ups, the CPM displays:

' **** WAIT **** '.

CAUSE: If the CPM is in the run mode. The Kneepot A/D converter reading doesn't changes by more than 2 counts, for a short predetermined amount of time. An error 15 is generated. The problem could be due to a faulty Kneepot, Kneepot cable.

CORRECTIVE ACTION: Check for a faulty Kneepot, or Kneepot cable. Reset EE_ EPROM byte by entering the calibration routine.

[E16]: CONFIGURATION ERROR.

ERROR ACTION: The error prevents the CPM from entering the run mode. It causes the pendant to display:

'EEPROM ERR [E16]'.

CAUSE: The CONFIG register is latched on power-up from a CONFIG byte in EPROM located at the same address. The CONFIG-register configure the micro controller. The EPROM CONFIG is burned each time the uC is put through calibration. If for some reason the CONFIG is not equal to the correct value, an error 16 is generated.

CORRECTIVE ACTION: This error is reset EE_ ERROR byte by performing the calibration routine. If error persists replace PCB and contact Danninger Medical Service Department informing the of this error.

[E17]: TOO MANY FORCE REVERSALS.

ERROR ACTION: This error causes the uC to burn 17 in the EE_ ERROR eprom and causes the CPM to stop. After further power-ups, the CPM displays:

'**** WAIT ****'.

CAUSE: If the unit has 7 force reversals in a 30 second period an error 17 will be generated.

CORRECTIVE ACTION: With the unit traveling, look for binding in the unit. Reset EE _ ERROR byte by entering the calibration routine.

[E18]: INVALID MOTOR TYPE.

ERROR ACTION: This error causes the CPM to exit the run mode causing the pendant to display:

'CALIBRATE [E18]'.

CAUSE: Calibration using A06 software and newer includes a motor type selection, "O" for Oriental, or "G" for Globe. If "O" is selected a zero is burned into the MOTOR TYPE byte in EPROM. If "C" is selected, a one is burned into MOTOR TYPE. After further power-ups, the MOTOR-TYPE is found to contain something other than a 0 or 1 an error 18 is generated.